

Application 2432

Constant Volume Electric Reheat with 2-Inch Water Column Measurement Range

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Overview

In Application 2432, the controller provides a constant volume of air to the room during occupied periods, and a lower constant volume of air to the room during unoccupied periods. Reheat is provided by three stages of electric heat. In order for the application to work properly, the central air handling unit must provide pre-conditioned air to the terminal box. This application will measure flows with differential pressure measurements up to two inches (up to a maximum of 5663 FPM). Refer to Figures 2432-1 and 2432-2.

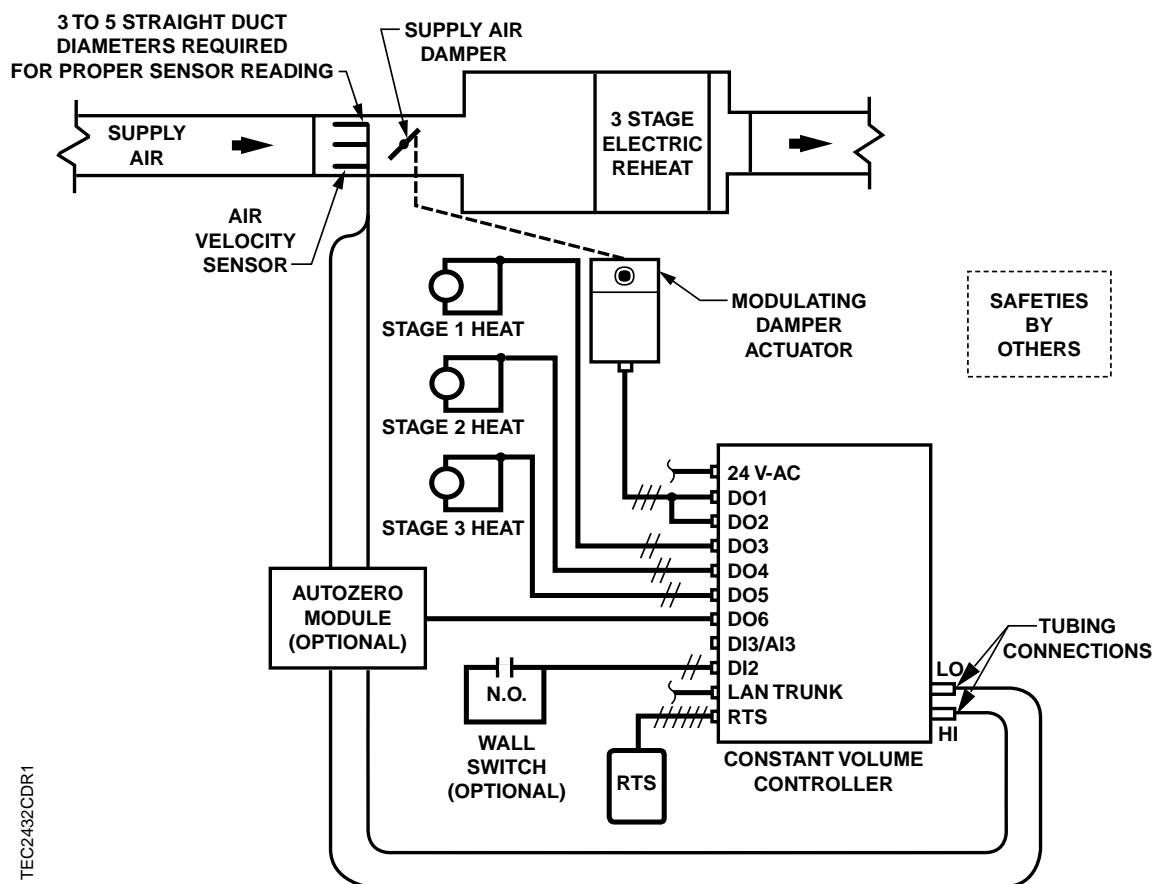
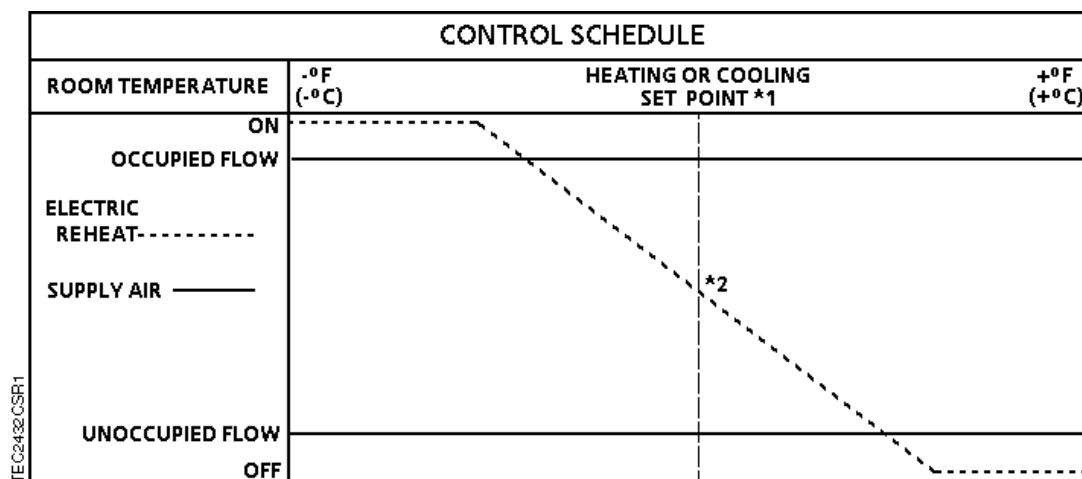


Figure 2432-1. Application 2432 Control Drawing.



1. Refer to *Control Temperature Set Points* section.
2. Electric reheat is time modulated. This allows it to be controlled proportionally rather than with deadbands.

Figure 2432-2. Application 2432 Control Schedule.

Hardware Inputs

Analog

- Air velocity sensor
- Room temperature sensor
- Room temperature set point dial (optional)

Digital

- Night mode override (optional)
- Wall switch (optional)

Hardware Outputs

Analog

- none

Digital

- Autozero Module (optional)
- Damper actuator
- Stage 1 electric reheat; or, 2-position heating valve
- Stage 2 electric reheat (optional)
- Stage 3 electric reheat (optional)

Ordering Notes

Constant Volume Controller with 2-Inch Water Column Measurement Range — Electronic Output: 540-100A. Refer to *APOGEE Automation Configuration and Sizing Guidelines* on InfoLink for other product numbers:

- Autozero Module (optional)
- Damper actuator
- Terminal Equipment Controller room temperature sensor

Sequence of Operation

The following paragraphs present the sequence of operation for Application 2432, "Constant Volume Electric Reheat with 2-Inch Water Column Measurement Range."

Control Temperature Set Points

Depending on the controller's current operational mode (occupied or unoccupied), the control temperature set point, CTL STPT (Point 92) holds the value of one of the following set points:

NOTE: Application 2432 will not automatically switch between heating and cooling. If a seasonal switchover (e.g., summer to winter) is to occur, then the field panel must command HEAT.COOL (Point 5). This allows the controller to use the appropriate set points for the season.

Occupied Mode – In occupied mode, CTL STPT holds the value of OCC CLG STPT (Point 6) in cooling mode and OCC HTG STPT (Point 7) in heating mode. If the room temperature sensor has a set point dial and STPT DIAL (Point 14) is set to YES, then CTL STPT holds the value of RM STPT DIAL (Point 13).

If the set point dial is used and the value of RM STPT DIAL is less than the value of RM STPT MIN (Point 11), then CTL STPT holds the value of RM STPT MIN. If the value of RM STPT DIAL is greater than the value of RM STPT MAX (Point 12), then CTL STPT holds the value of RM STPT MAX.

Unoccupied Mode – In unoccupied mode, CTL STPT holds the value of UOC CLG STPT (Point 8) in cooling mode and UOC HTG STPT (Point 9) in heating mode. The set point dial is not used in unoccupied mode.

NOTE: The value of CTL TEMP (Point 78) is the same as the value of ROOM TEMP (Point 4), unless CTL TEMP is overridden.

Occupied and Unoccupied Modes

The occupied/unoccupied status of the space is determined by the status of OCC.UNOCC (Point 29). The control of this point differs depending on whether the controller is monitoring the status of a wall switch or if the controller is connected to a field panel.

When a wall switch is physically connected to the termination strip on the controller at DI 2 (Figures 2432-1 and 2432-3), and WALL SWITCH (Point 18) equals YES, the controller monitors the status of DI 2. When the status of DI 2 (Point 24) is ON (the switch is closed), then OCC.UNOCC will be set to OCC indicating that the controller is in occupied mode. When the status of DI 2 is OFF (the switch is open), then OCC.UNOCC will be set to UNOCC indicating that the controller is in unoccupied mode.

When WALL SWITCH equals NO, the controller does not monitor the status of the wall switch, even if one is connected to it. In this case, and if the controller is operating stand-alone, then the controller stays in occupied mode all the time. If the controller is operating with centralized control (that is, it is connected to a field panel), then the field panel can send an operator or PPCL command to override the status of OCC.UNOCC. Refer to *Powers Process Control Language (PPCL) User's Manual* (125-1896) and *Field Panel User's Manual* (125-1895) for more information.

Unoccupied Mode Override Switch

If an override switch is present on the room temperature sensor and a value (in hours) other than zero has been entered into the OVRD TIME (Point 20), then by pressing the override switch a room occupant can reset the controller to occupied operational mode for the amount of time that is set in OVRD TIME. The status of the UNOCC OVRD (Point 21) changes to OCC. After the override time elapses, the controller returns to unoccupied mode and the status of UNOCC OVRD changes back to UNOCC.

It is only when the controller is in unoccupied mode that the override switch on the room temperature sensor will have any effect on the controller.

Control Loops

Flow Loop – The flow loop maintains FLOW STPT by modulating the supply air damper point, DMPR COMD (Point 48). The flow loop maintains the airflow at either OCC FLOW (Point 32) or UNOCC FLOW (Point 31) depending on the value of OCC.UNOCC.

The FLOW (Point 75) is the input value for the flow loop. It is calculated as a percentage based on where the AIR VOLUME (Point 35) is between 0 CFM (LPS) and OCC FLOW. In the following text, this percentage is referred to as % flow.

- If AIR VOLUME equals 0 CFM (LPS), then FLOW is 0% flow.
- If AIR VOLUME equals OCC FLOW, then FLOW is 100% flow.

The FLOW STPT percentage that corresponds to UNOCC FLOW is calculated as:
 $(\text{UNOCC FLOW} \div \text{OCC FLOW}) \times 100\% \text{ flow.}$

For example, if UNOCC FLOW equals 250 CFM, and if OCC FLOW equals 1000 CFM, then, in unoccupied mode the FLOW STPT = $(250 \text{ CFM} \div 1000 \text{ CFM}) \times 100\% \text{ flow} = 0.25 \times 100\% \text{ flow} = 25\% \text{ flow.}$

Since 25% of 1000 CFM equals 250 CFM, the flow set point in unoccupied mode will be 25%. UNOCC FLOW can be set less than or equal to, but not greater than OCC FLOW.

Temperature Loop – The temperature loop will modulate HTG LOOPOUT (Point 80) and control the electric reheat in order to maintain the room temperature in both heating and cooling modes.

Electric Reheat



CAUTION:

Verify that the equipment is supplied with safeties by others to ensure that there is airflow across the heating coils when they are to be energized.

The heating loop controls up to three stages of electric reheat to maintain the room temperature. The electric reheat is time modulated using a duty cycle as shown in the following example.

Example: If the duty cycle is 10 minutes (STAGE TIME (Point 89) is set to 10 minutes) and the temperature loop is calling for 60% of heating (HTG LOOPOUT (Point 80) is set to 60%), then for every 10 minute period, the stages of electric auxiliary heat cycle as follows:

	Stage 1: minutes		Stage 2: minutes		Stage 3: minutes	
	ON	OFF	ON	OFF	ON	OFF
With 1 stage of electric heat:	6	4	--	--	--	--
With 2 stages of electric heat:	10	0	2	8	--	--
With 3 stages of electric heat:	10	0	8	2	0	10

Electric Heat Interlock

The electric heat stages are enabled as long as FLOW (Point 75) is greater than EHEAT FLOW (Point 60). The electric heat stages will not be disabled (turned OFF) until the FLOW is less than EHEAT FLOW minus 5%. Once disabled, FLOW must become greater than EHEAT FLOW before the electric heat stages will return to normal control.



CAUTION:

Do not set EHEAT FLOW to less than 5%, otherwise the electric heat interlock will be disabled.

Calibration

Air Velocity Transducer – Calibration of the controller's internal air velocity transducer is periodically required to maintain accurate air velocity readings. The CAL SETUP (Point 95) is set with the desired calibration option during controller start-up. Depending upon the value of CAL SETUP, calibration may be set to take place automatically or manually when the override switch is pressed on the room temperature sensor. If the value of CAL AIR (Point 94) is YES, then calibration is in progress.

- For a controller used without an Autozero Module (CAL MODULE (Point 87) = NO), the damper is commanded closed to get a zero airflow reading during calibration.

- For a controller used with an Autozero Module (CAL MODULE = YES), calibration occurs without closing the damper. (**Note:** The first time after start-up or initialization, the controller will calibrate the damper as if not using an Autozero Module, although the Autozero Module will be activated. All subsequent calibrations will use the Autozero Module only).

At the end of a calibration sequence, CAL AIR returns to NO automatically. A status of NO indicates that the controller is not in a calibration sequence.

The Autozero Module is enabled when it is wired to DO 6 and CAL MODULE (Point 87) is set to YES.

Damper Status Operation

Under normal operation the DMPR STATUS (Point 84) reads "CAL". However, when using an Autozero Module, it is possible that the calculated damper position, DMPR POS (Point 49), may differ from the actual (physical) damper position after a long period of operation or after initialization or return from power loss.

If this occurs, the controller will automatically compensate for any difference by setting DMPR STATUS to "RECAL" which readjusts the value of DMPR POS. DMPR STATUS will be set to "RECAL" if one of the following two sets of conditions is true:

- DMPR POS = 100%
Air velocity (AIR VOLUME (Point 35) ÷ DUCT AREA (Point 97)) > 200 FPM
FLOW (Point 75) < FLOW STPT (Point 93)
- DMPR POS = 0%
Air velocity (AIR VOLUME ÷ DUCT AREA) > 200 FPM
FLOW > FLOW STPT

If DMPR STATUS has been changed to "RECAL" in response to one of the conditions described above, then do one of the following:

1. If flow is now being properly controlled, then set DMPR STATUS to **CAL** and release it.
2. If flow is still not being properly controlled (i.e., one of the conditions described above is still present), then initialize the controller.

If these steps do not fix the problem of maintaining flow, then a mechanical problem might exist.

Fail-safe Operation

If the air velocity sensor fails, then the controller determines the status of FAIL MODE (Point 40) and positions the damper accordingly. If FAIL MODE equals OPEN and the velocity sensor fails, then the damper will open. If FAIL MODE equals CLOSED (the default) and the velocity sensor fails, then the damper will close.

If the room temperature sensor fails, then the controller holds the last known temperature value.

Application Notes

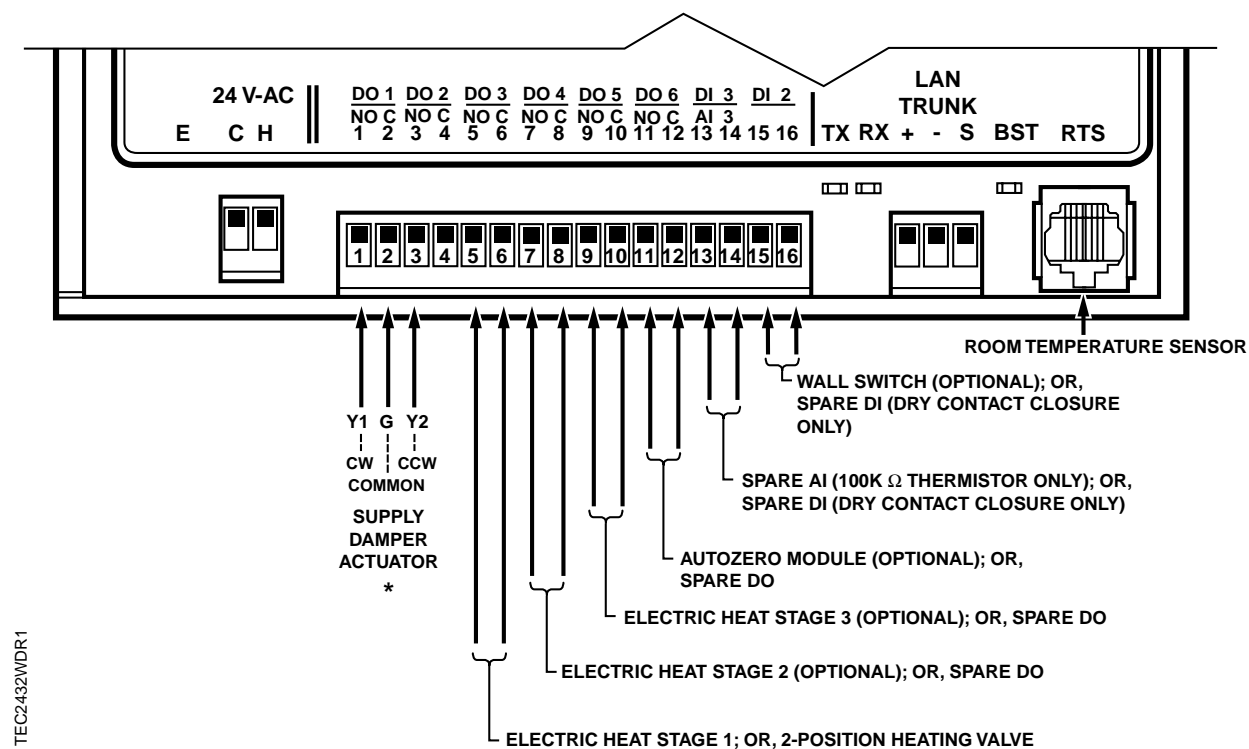
1. If the temperature swings in the room are excessive, or if there is trouble in maintaining the room temperature set point, then the temperature loop needs to be tuned. If FLOW (Point 75) is oscillating while the FLOW STPT (Point 93) is constant, then the flow loop requires tuning. Refer to *APOGEE Automation Service Procedures* on InfoLink for more information.
2. The Constant Volume Controller – Electronic Output, as shipped from the factory, keeps all associated equipment OFF. Refer to the *Equipment Controllers* section in *APOGEE Automation Start-up Procedures* on InfoLink for information on how to release the controller and its equipment to application control.
3. Spare DOs can be used as auxiliary points that are controlled by the field panel after being defined in the field panel's database. DO 3 (HEAT STAGE 1), DO 4 (HEAT STAGE 2), and DO 5 (HEAT STAGE 3) control the stages of electric heat. If less than three stages are being controlled by the application, then the DOs not used are spare. If DO 6 is not used for an Autozero Module, then it is spare. Refer to *APOGEE Automation Start-up Procedures* on InfoLink for more information.

Wiring Diagram



CAUTION:

The Constant Volume Controller controls 24 Vac loads only. The maximum rating is 12 VA for each DO. For higher VA requirements, 110 or 220 Vac requirements, or DC power requirements, use an interposing 220V 4-relay module.



* REFER TO THE ACTUATOR INSTALLATION INSTRUCTIONS FOR SPECIFIC WIRING TERMINATIONS

Figure 2432-3. Application 2432 Wiring Diagram

Point Database

Table 2432-1. Point Database for Application 2432.

Point Number	Descriptor	Factory Default (SI Units)	Engr Units (SI Units)	Slope (SI Units)	Intercept (SI Units)	On Text	Off Text
01	CTLR ADDRESS	99	--	1	0	--	--
02	APPLICATION	2092	--	1	0	--	--
{04}	ROOM TEMP	74.0 (23.44888)	DEG F (DEG C)	0.25 (0.14)	48.0(8.88888)	--	--
{05}	HEAT.COOL	COOL	--	--	--	HEAT	COOL
06	OCC CLG STPT	70.0 (21.20888)	DEG F (DEG C)	0.25 (0.14)	48.0(8.88888)	--	--
07	OCC HTG STPT	70.0 (21.20888)	DEG F (DEG C)	0.25 (0.14)	48.0(8.88888)	--	--
08	UOC CLG STPT	65.0 (18.40888)	DEG F (DEG C)	0.25 (0.14)	48.0(8.88888)	--	--
09	UOC HTG STPT	65.0 (18.40888)	DEG F (DEG C)	0.25 (0.14)	48.0(8.88888)	--	--
11	RM STPT MIN	55.0 (12.80888)	DEG F (DEG C)	0.25 (0.14)	48.0(8.88888)	--	--
12	RM STPT MAX	90.0 (32.40888)	DEG F (DEG C)	0.25 (0.14)	48.0(8.88888)	--	--
{13}	RM STPT DIAL	74.0 (23.44888)	DEG F (DEG C)	0.25 (0.14)	48.0(8.88888)	--	--
{14}	STPT DIAL	NO	--	--	--	YES	NO
{15}	AUX TEMP	74.0 (23.495556)	DEG F (DEG C)	0.5 (0.28)	37.5(3.055556)	--	--
18	WALL SWITCH	NO	--	--	--	YES	NO
{19}	DI OVRD SW	OFF	--	--	--	ON	OFF
20	OVRD TIME	0	HRS	1	0	--	--
{21}	UNOCC OVRD	UNOCC	--	--	--	UNOCC	OCC
{24}	DI 2	OFF	--	--	--	ON	OFF
{25}	DI 3	OFF	--	--	--	ON	OFF
{29}	OCC.UNOCC	OCC	--	--	--	UNOCC	OCC
{31}	UNOCC FLOW	220 (103.818)	CFM (LPS)	4 (1.8876)	0	--	--
{32}	OCC FLOW	2200 (1038.18)	CFM (LPS)	4 (1.8876)	0	--	--
{35}	AIR VOLUME	0 (0.0)	CFM (LPS)	4 (1.8876)	0	--	--
36	FLOW COEFF	1.0	--	0.01	0.0	--	--
40	FAIL MODE	CLOSED	--	--	--	CLOSE D	OPEN
{41}	DO 1	OFF	--	--	--	ON	OFF
{42}	DO 2	OFF	--	--	--	ON	OFF

1. Points not listed are not used in this application.
2. A single value in a column means that the value is the same in English units and in SI units.
3. Point numbers that appear in brackets { } may be unbundled at the field panel.

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Table 2432-1. Point Database for Application 2432.

Point Number	Descriptor	Factory Default (SI Units)	Engr Units (SI Units)	Slope (SI Units)	Intercept (SI Units)	On Text	Off Text
{43}	HEAT STAGE 1	OFF	--	--	--	ON	OFF
{44}	HEAT STAGE 2	OFF	--	--	--	ON	OFF
{45}	HEAT STAGE 3	OFF	--	--	--	ON	OFF
{46}	DO 6	OFF	--	--	--	ON	OFF
{48}	DMPR COMD	0.0	PCT	0.4	0.0	--	--
{49}	DMPR POS	0.0	PCT	0.4	0.0	--	--
51	MTR1 TIMING	95	SEC	1	0	--	--
56	DPR1 ROT ANG	90	--	1	0	--	--
58	MTR SETUP	0	--	1	0	--	--
59	DO DIR.REV	0	--	1	0	--	--
60	EHEAT FLOW	20.0	PCT	0.4	0.0	--	--
67	HTG P GAIN	10.0 (18.0)	--	0.25 (0.45)	0.0	--	--
68	HTG I GAIN	0.012 (0.0216)	--	0.001 (0.0018)	0.0	--	--
69	HTG D GAIN	0 (0.0)	--	2 (3.6)	0	--	--
70	HTG BIAS	0.0	PCT	0.4	0.0	--	--
71	FLOW P GAIN	0.25	--	0.05	0.0	--	--
72	FLOW I GAIN	0.018	--	0.001	0.0	--	--
73	FLOW D GAIN	0	--	2	0	--	--
74	FLOW BIAS	50.0	PCT	0.4	0.0	--	--
{75}	FLOW	0.0	PCT	0.25	0.0	--	--
{78}	CTL TEMP	74.0 (23.44888)	DEG F (DEG C)	0.25 (0.14)	48.0(8.88888)	--	--
{80}	HTG LOOPOUT	0.0	PCT	0.4	0.0	--	--
{81}	AVG HEAT OUT	0	--	2	0	--	--
82	STAGE MAX	90.0	PCT	0.4	0.0	--	--
83	STAGE MIN	10.0	PCT	0.4	0.0	--	--
{84}	DMPR STATUS	CAL	--	--	--	RECAL	CAL
87	CAL MODULE	NO	--	--	--	YES	NO
88	STAGE COUNT	3	--	1	0	--	--

1. Points not listed are not used in this application.
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3. Point numbers that appear in brackets { } may be unbundled at the field panel.

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Table 2432-1. Point Database for Application 2432.

Point Number	Descriptor	Factory Default (SI Units)	Engr Units (SI Units)	Slope (SI Units)	Intercept (SI Units)	On Text	Off Text
89	STAGE TIME	10	MIN	1	0	--	--
{91}	TOTAL VOLUME	0 (0)	CF (L)	4 (113)	0	--	--
{92}	CTL STPT	74.0 (23.44888)	DEG F (DEG C)	0.25 (0.14)	48.0(8.88888)	--	--
{93}	FLOW STPT	0.0	PCT	0.25	0.0	--	--
{94}	CAL AIR	NO	--	--	--	YES	NO
95	CAL SETUP	4	--	1	0	--	--
96	CAL TIMER	12	HRS	1	0	--	--
97	DUCT AREA	1.0 (0.09292)	SQ. FT (SQ M)	0.025 (0.002323)	0.0	--	--
98	LOOP TIME	5	SEC	1	0	--	--
{99}	ERROR STATUS	0	--	1	0	--	--

1. Points not listed are not used in this application.
2. A single value in a column means that the value is the same in English units and in SI units.
3. Point numbers that appear in brackets { } may be unbundled at the field panel.